

Historical Barge Shipments of Spent Nuclear Fuel

Kevin Connolly
Oak Ridge National Laboratory

December 2022
Southern States Energy Board
Joint Meeting of the Radioactive Materials Transportation Committee & the
Transuranic Waste Transportation Working Group

Dallas

Disclaimer

- This is a technical presentation that does not take into account contractual limitations or obligations under the Standard Contract for Disposal of Spent Nuclear Fuel and/or High-Level Radioactive Waste (Standard Contract) (10 CFR Part 961). For example, under the provisions of the Standard Contract, spent nuclear fuel in multi-assembly canisters is not an acceptable waste form, absent a mutually agreed to contract amendment. To the extent discussions or recommendations in this presentation conflict with the provisions of the Standard Contract, the Standard Contract governs the obligations of the parties, and this presentation in no manner supersedes, overrides, or amends the Standard Contract.
- This presentation reflects technical work that could support future decision making by the US Department of Energy (DOE or Department). No inferences should be drawn from this presentation regarding future actions by DOE, which are limited both by the terms of the Standard Contract and Congressional appropriations for the Department to fulfill its obligations under the Nuclear Waste Policy Act including licensing and construction of a spent nuclear fuel repository.

Outline

- **BONUS reactor shipments from Puerto Rico**
- **Shipments from Shoreham Nuclear Power Station**
- **Shipments on Neckar River, Germany**

Irradiated fuel* was moved from Puerto Rico by ship in 1968 and 1969

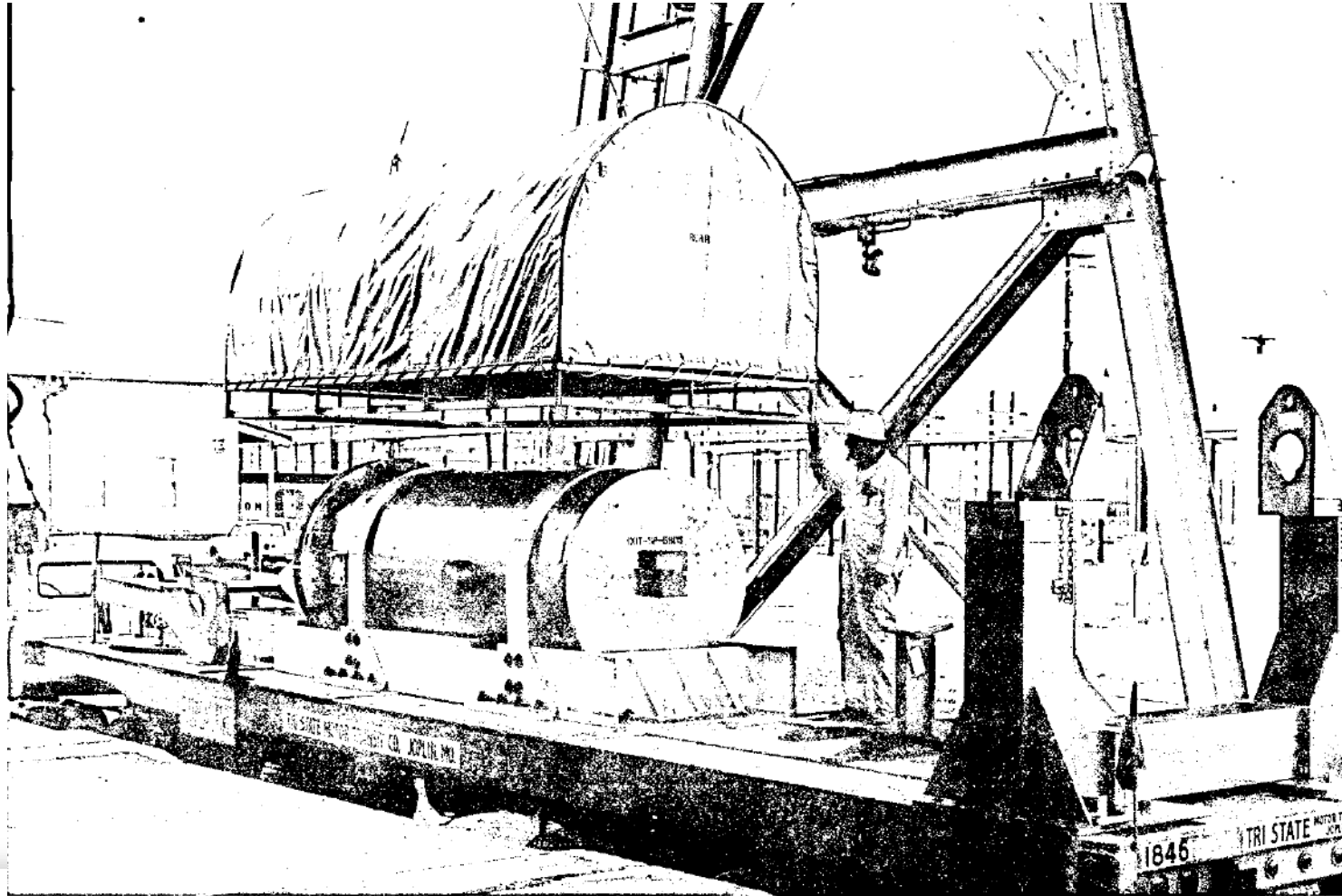
- **Boiling Nuclear Superheater (BONUS) Reactor in Rincon, Puerto Rico, operated intermittently between January 1966 and August 1967**
- **The reactor was decommissioned in 1968**
 - **Part of decommissioning involved removing the fuel and control rods**
 - **Destination for SNF: reprocessing plant in West Valley, New York**
 - **Destination for control rods: burial site in Oak Ridge, Tennessee**
- **100 SNF assemblies to be shipped from Rincon, Puerto Rico to West Valley, New York**

*The terms “irradiated nuclear fuel” and “spent nuclear fuel (SNF)” are used interchangeably.

BONUS shipments were planned using an existing SNF cask

- **The ATCOR cask, used for other shipments at the time, was chosen since it could be loaded onto a trailer and driven on and off of a ship**
 - The basket had to be fabricated specially for the BONUS fuel
 - Additional cask reinforcements were also made to ensure safety in the event of a 30-foot drop
 - Loaded cask weight: approximately 35 tons
 - A canvas sun shield kept the cask in the shade during transport
 - Cask surface temperature was expected to be ~130 °F in the sun, ambient in shade
- **Operating procedures were tested prior to shipments**

Cask used for BONUS shipments, on trailer with sunshade



W. A. Pryor, "Irradiated Fuel and Control Rods Transport from a Decommissioned Power Reactor," *Proceedings of the Eight Midyear Topical Symposium of the Health Physics Society*, Knoxville, Tenn., October 1974.

U.S. DEPARTMENT OF
ENERGY

Office of
NUCLEAR ENERGY

BONUS SNF was shipped by road and sea

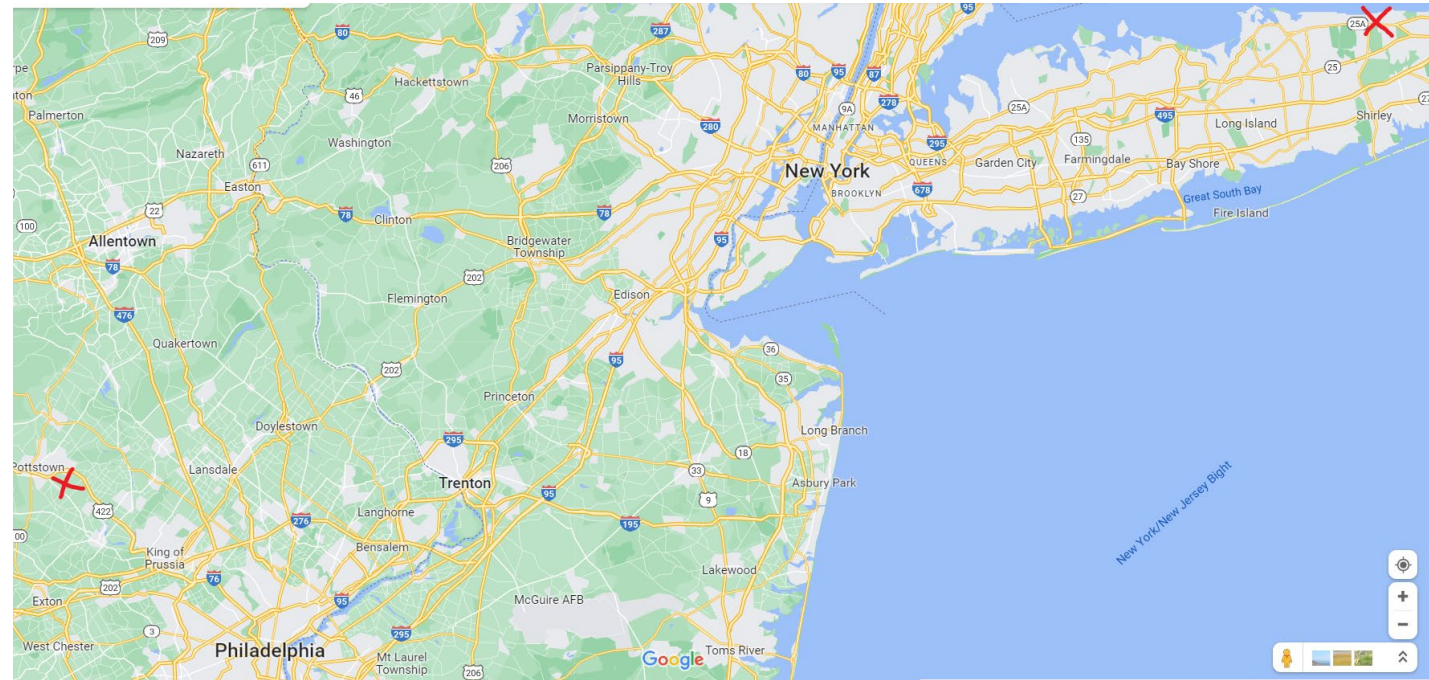
- **Six shipments were made between December 1968 and July 1969**
- **First leg of shipments: 75 miles from BONUS reactor in Rincon to San Juan, Puerto Rico by road**
- **Second leg of shipments: 1600 miles by ship from San Juan to Port of New York**
- **Third leg of SNF shipments: 300 miles by road from Port of New York to West Valley, New York**
 - Third leg of control rod shipments: 900 miles by road from Port of New York to Oak Ridge, Tennessee

Shipments were successful but not without incident

- **A longshoremen's strike delayed shipments two and a half months from the original schedule**
 - During the strike, a loaded cask had to be stored at the US Navy base in San Juan until shipping resumed
- **A ship broke down at sea, and was towed to port**
 - Contracts with a different steamship company were made to complete the shipments

In 1993 and 1994, lightly irradiated fuel was moved from Shoreham nuclear power plant

- **SNF moved by three modes: road, barge, and rail**
 - Destination: Limerick nuclear power plant
- **18 shipments made in 1993**
 - 306 assemblies shipped
- **15 shipments made in 1994**
 - 254 assemblies shipped



Multiple modes of shipping added complexity

- **Short heavy haul from reactor to barge slip**
- **Barge transportation to Eddystone, Pennsylvania**
- **Rail transportation to Limerick**
 - Rail chosen instead of truck for safety reasons, although there were cost considerations as well
 - Rail transportation to Limerick allowed for fewer shipments than road transportation
 - Public interest in shipments: rail near downtown Philadelphia
- **Transporting SNF by heavy haul to barge to rail had never been done before**

Beginning to plan shipments with plenty of time in advance was a key to success

- **Early planning began four years prior to shipments**
 - Limerick was not the only destination considered
- **Campaign logistics planning was crucial**
 - Near-site and on-site transportation infrastructure, cask availability, fuel characteristics, and schedule were important factors
 - Shipments were paused while Limerick had a planned refueling outage
- **Public and media were informed of shipments**
 - An information session was held in downtown Philadelphia for public and press
- **Barge route identification process affected by state and local statutes**

SNF was moved by barge between nuclear power plants in Germany in 2017

- **342 SNF assemblies were stored in 15 casks at the shutdown Obrigheim nuclear power plant**
- **SNF was moved to storage facility at Neckarwestheim nuclear power plant**
 - The two nuclear power plants both had the same owner, both were located near the Neckar River with barge access, and neither had rail access
- **SNF had never been moved by inland waterway in Germany**

3 casks were moved in each barge shipment



Fig. 9. Departure of river barge and pusher tug 'RONJA' from RORO berth of NPP Obrigheim.



Fig. 8. Loading of cask type CASTOR[®] 440/84 mvK at the berth of NPP Obrigheim.



Fig. 12. Unloading Road Trailer with cask from river barge at the RORO berth of NPP Neckarwestheim.

O. Patzold and C. Kobel, "Challenges and Experiences on the Performance of the First Security Transport of SNF on Inland Waterways in Germany," *PATRAM 2019*, New Orleans, La., August 2019.

Barge mode was chosen for these shipments for several reasons

- **Since neither plant had rail access, transload to rail would have required a crane**
- **Barge transportation allowed for roll-on, roll-off of SNF casks on trailers – eliminating the need for a crane**
- **Barge shipments were farther from homes and businesses than road shipments would have been**
- **Barge shipments eliminated the need to consider bridge weight limits and narrow roads**

SNF has been shipped by vessel regularly

- **In addition to the campaigns mentioned in this presentation, SNF has regularly been shipped by vessel**
 - Sweden and Japan have made virtually all of their SNF shipments by vessel for decades
 - Other countries have shipped SNF via vessel to the UK and France for reprocessing, and the resulting HLW has been returned via vessel
 - Research reactor fuel of US origin has been transported to the US by ship for many years as part of the Foreign Research Reactor SNF Return Program

Summary

- SNF has been moved by ship and barge in the US and Germany, although not regularly
- Historical information on SNF transportation may be found at <https://www.energy.gov/ne/articles/historical-review-safe-transport-spent-nuclear-fuel>
 - A new revision to this report will be released in the near future
- Open discussion